

## **8 ADAPTIVE MANAGEMENT, RESEARCH, MONITORING, AND EVALUATION**

In 2008, after NMFS adopts the Lake Ozette Sockeye Recovery Plan, NMFS will develop a detailed adaptive management and monitoring plan, together with an implementation plan, in coordination with the PSTRT, Lake Ozette Steering Committee, and co-managers.

### **8.1 ADAPTIVE MANAGEMENT**

Because of the length and complexity of the salmonid life cycle, there are many uncertainties involved in improving salmonid survival. Simply identifying cause-and-effect relationships between any given management action and characteristics of salmon populations can be a scientific challenge. It is essential to design a monitoring and evaluation program that will answer these basic questions: How will we know we are making progress? How will we get the information we need? And how will we use the information in decision making?

As part of implementing the Lake Ozette sockeye salmon recovery plan, a detailed monitoring and evaluation program will be designed and incorporated into an adaptive management framework based on the principles and concepts laid out in the NMFS guidance document, *Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance* (available at <http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other-Documents.cfm>).

Adaptive management is the process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation, and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary.

As outlined in the NMFS *Adaptive Management* guidance document, several types of monitoring are needed: (1) implementation and compliance monitoring, which is used to evaluate whether the recovery plan is being implemented; (2) status and trend monitoring, which assesses changes in the status of an ESU and its component populations, as well as changes in status or significance of the threats to the ESU; and (3) effectiveness monitoring, which tests hypotheses and determines (via research) whether an action is effective and should be continued. In addition, it's important to build in some research to illuminate the many unknowns in salmon recovery—the “critical uncertainties” that make management decisions all the harder. Critical uncertainty

## PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

research may seem expensive or unnecessary in light of basic information needs; however, in the long run, it may reduce monitoring and implementation costs.

Implementation and compliance monitoring simply check on whether activities were carried out as planned, and whether specified criteria are being met as a direct result of an implemented action. For example, if a fence is planned for 2 miles of stream corridor to keep livestock off the stream banks so that riparian vegetation will rebound, implementation monitoring would verify the presence of the fence. Compliance monitoring would take note of the presence or absence of livestock in the fenced-off area.

Status and trend monitoring is a simple compilation of data-based descriptions of existing conditions. To be useful in decision making, the raw data, or metrics, must be reduced to a more directly applicable form or indicator. For example, if the question is “What is the annual population size of sockeye spawning in the Big River?” the indicator would be total spawning numbers of sockeye over one season for the entire subbasin; however, the metric, or directly measured thing, would be something quite different, perhaps live sockeye sighted on weekly passes within the indexed spawning grounds. Thus, the metric must be processed to translate it from the metric data type (e.g., observed sockeye) into the indicator data type (e.g., total spawners), and then reduced to generate the indicator required (e.g., “reduce” list of weekly counts on spawning grounds to annual total for watershed).

Effectiveness monitoring specifically addresses cause-and-effect questions.

Demonstrating the direct and indirect impact of management actions requires supporting all steps in the logical chain that connects the action to its expected impact. This chain is rarely short and usually contains several hypotheses. For this reason, it’s better to build the effectiveness monitoring into the recovery action strategies, with, for example, pilot-scale tests or other methods carefully thought out beforehand. Monitoring and evaluation will only provide the answers to the questions they were designed to address; they do not provide the framework for revising these questions if they are ill-posed, evaluating the assumptions upon which the strategy was built, or incorporating learning into future decisions on actions and strategies—this is the role of adaptive management.

NMFS’ guidance document presents a decision framework that can guide the design of a research, monitoring, and evaluation plan. The framework (Figure 8.1) contains two basic sorts of questions: (1) questions regarding ESU status (biological viability criteria) and (2) questions regarding statutory listing factors and factors limiting recovery (limiting factor and threats criteria). Evaluating a species for potential delisting requires an explicit analysis of both types of criteria.

The guidance document contains a more detailed discussion of the framework and identifies the specific questions that must be answered to evaluate ESU status. These specific questions take the form of a series of decision-question sets that address the status and change in status of a salmonid ESU and the risks posed by threats to the ESU. The decision-question sets are designed to elicit the information NMFS needs to make

## PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

delisting decisions. For recovery planners, the framework can guide future decisions about strategies and actions aimed at achieving recovery goals.

Designing an effective monitoring program for salmon recovery involves the following initial steps:

1. Clarify the questions that need to be answered for policy and management decision making. Include the full ESU and the full salmonid life cycle.
2. Identify entity or entities responsible for coordinating development of this program.
3. Identify:
  - Which populations and associated limiting factors to monitor
  - Metrics and indicators
  - Frequency, distribution, and intensity of monitoring
  - Tradeoffs and consequences of these choices
4. Assess the degree to which existing monitoring programs are consistent with NMFS guidance.
5. Identify needed adjustments in existing programs, additional monitoring needs, and strategy for filling those needs.
6. Develop a data management plan (See Appendix B of the NMFS guidance document).
7. Prioritize research needs for critical uncertainties, testing assumptions, etc.
8. Identify entities responsible for implementation.

The Lake Ozette sockeye salmon monitoring and evaluation program will build on existing programs designed for monitoring tributary and lake habitat, hatchery programs, and actions outside of the Lake Ozette watershed (e.g., ocean harvest). The Ozette sockeye monitoring and evaluation program will provide (1) a clear statement of the metrics and indicators by which progress toward achieving goals can be assessed, (2) a plan for tracking such metrics and indicators, and (3) a decision framework through which new information from monitoring and evaluation can be used to adjust strategies or actions aimed at achieving the plan's goals.

# PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

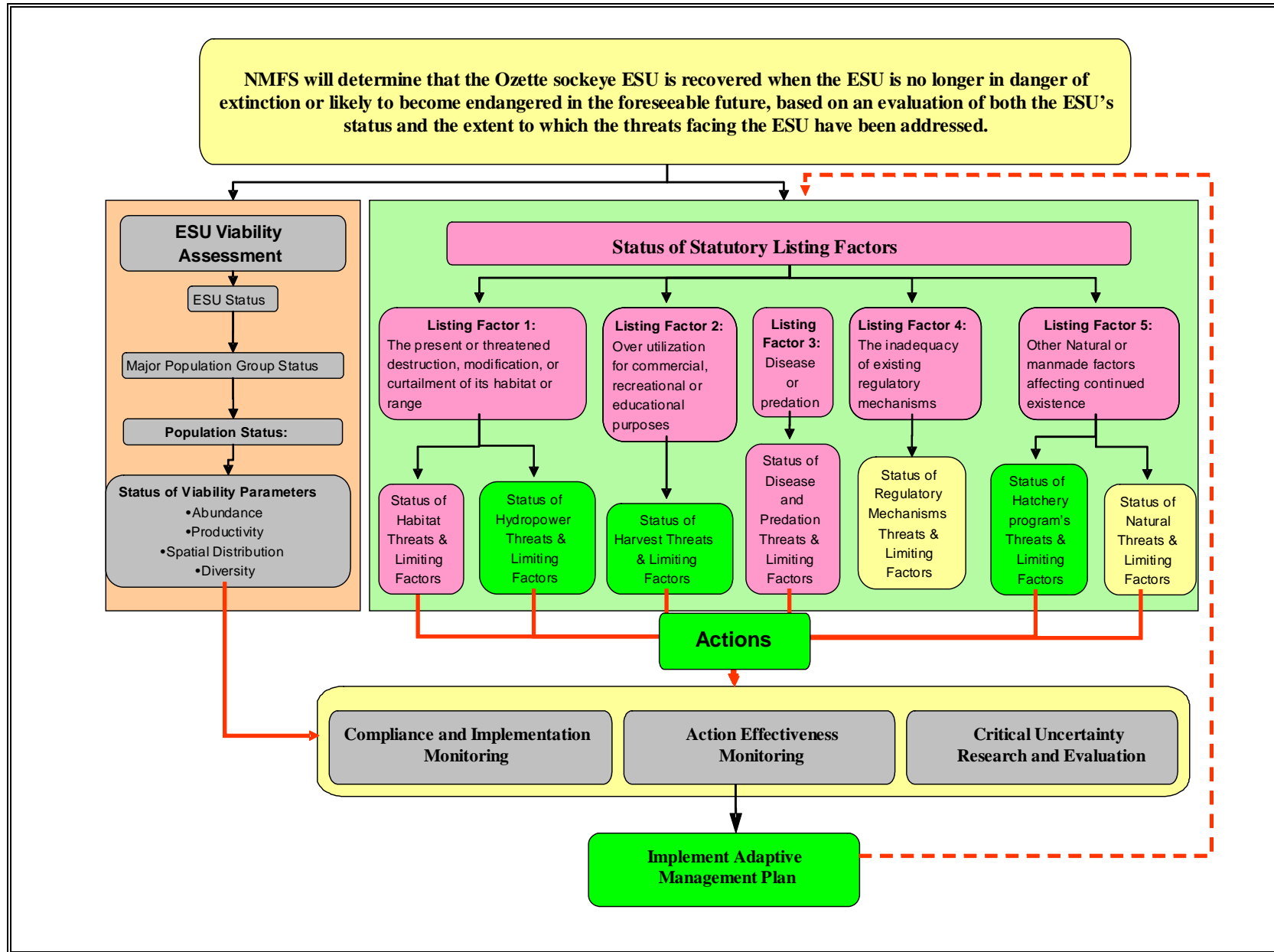


Figure 8.1. NMFS listing status decision framework.

## 8.2 RESEARCH AND MONITORING

In 2008, a detailed Monitoring and Adaptive Management Plan, together with an Implementation Plan, will be developed in coordination with the PSTRT, Lake Ozette Steering Committee and co-managers after the Lake Ozette Sockeye Recovery Plan is adopted by NMFS. The following table lists research, monitoring, and evaluation needed for long-term, effective decision making regarding Lake Ozette sockeye recovery. (Note that some of the recommended research and monitoring is already ongoing as part of the HGMP.)

Table 8.1. Research, monitoring, and evaluation needs for long-term decisionmaking (not prioritized)

<b>RM&amp;E ID</b>	<b>Affected Population Segment</b>	<b>Process or Condition to Investigate</b>	<b>Geographic Location</b>	<b>Description</b>
<b>RME#1</b>	All Population Segments	Streamflow	Ozette River	Continue to monitor Ozette River streamflow. Investigate effects of reduced streamflow on run timing and sockeye fitness.
<b>RME#2</b>	All Population Segments	Sediment	Ozette River and Coal Creek	Continue to collect turbidity and SSC data in Coal Creek.
<b>RME#3</b>	All Population Segments	Thermal	Ozette River	Continue and expand Ozette River stream temperature monitoring program.
<b>RME#4</b>	All Population Segments	Biological	Lake Ozette and Ozette River	Continue and expand on all sockeye population monitoring (run size and timing, smolt production, spawning escapement, etc...). Conduct biological monitoring included in the LOS HGMP.
<b>RME#5</b>	All Population Segments	Biological	Lake Ozette and Ozette River	Develop and implement program to monitor and evaluate predator-prey interactions in Lake Ozette and the Ozette River.
<b>RME#6</b>	All Population Segments	Biological	Lake Ozette and Ozette River	Re-evaluate the impacts of Lake Ozette fishing regulations (e.g., non-retention of cutthroat trout)
<b>RME#7</b>	All Population Segments	Biological	Lake Ozette	Examine lake holding mortality factors and rates from predation, disease, and other factors.

PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

<b>RM&amp;E ID</b>	<b>Affected Population Segment</b>	<b>Process or Condition to Investigate</b>	<b>Geographic Location</b>	<b>Description</b>
<b>RME#8</b>	All Population Segments	Biological Limnological Conditions	Lake Ozette	Include limnological monitoring focused on temperature, water quality, photosynthetic rates, and zooplankton communities and sockeye salmon.
<b>RME#9</b>	All Population Segments	Biological	Lake Ozette	Temporal and spatial distribution of sockeye fry remains unknown. It is generally assumed that Ozette sockeye fry quickly migrate to the pelagic zone upon emergence. Studies to determine nearshore habitat utilization after emergence could aid in understanding predator prey relationships, as well as food type and availability during the fry stage.
<b>RME#10</b>	All Population Segments	Habitat Condition #1	Ozette River	Do large logjams that form deep pools in the Ozette river provide important refugia habitat for adult sockeye salmon? Do deep pools provide thermal refugia habitat for adult sockeye? How do habitat complexity and/or simplification affect predation of adult sockeye?
<b>RME#11</b>	All Population Segments	Habitat Condition #2	Ozette River	Are there unique tidal prism influences that enhance or are detrimental to the sockeye life cycle? Quantify the changes in estuary volumes and habitat availability over time in response to altered spit morphology at the ocean mouth. Analyze sequential historic photos, in conjunction with field surveys. How has nutrient and salinity exchange changed in the estuary and how has this

PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

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				affected sockeye rearing and migration habitat?
<b>RME#12</b>	Beach Spawners	Sediment	Lake Ozette	Key questions include: Is there evidence of anthropogenic impacts on water quality in the lake? If so, to what extent have any changes affected beach spawning sockeye? What are the patterns and concentrations of turbidity/SSC across the lake and along different beach habitats during various storm events? What beaches/locations are more susceptible to habitat degradation caused by fine sediment deposition? Is water quality changing over time?
<b>RME#13</b>	Beach Spawners	Biological	Lake Ozette	What percent of beach spawners are consumed prior to spawning? Which predators consume more sockeye salmon? Do river otters forage on sockeye carcasses left by harbor seals?
<b>RME#14</b>	Beach Spawners	Biological	Lake Ozette	Investigate predation of emergent fry during their off-shore emigration from spawning beaches to the limnetic zone of Lake Ozette (e.g., coho salmon predation)
<b>RME#15</b>	Beach Spawners	Biological	Lake Ozette	Continue and expand upon adult sockeye predation studies on spawning beaches. Key questions include: How many sockeye spawn each year on each beach? Are other beach spawning areas also utilized?

PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

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				Are secondary areas such as north Olsen's and Cemetery Point used each year and to what degree?
<b>RME#16</b>	Beach Spawners	Biological	Lake Ozette	How many kokanee or kokanee size <i>O. nerka</i> spawn annually with sockeye salmon on the beaches? What effect does this level of hybridization have on the population? Are there increasing numbers of kokanee spawning with sockeye on the beaches?
<b>RME#17</b>	Beach Spawners	Habitat Condition #3	Lake Ozette	Investigate several different methods of beach spawning habitat rehabilitation including: vegetation removal, gravel cleaning, LWD introduction, etc...Include sockeye egg survival studies with habitat manipulations.
<b>RME#18</b>	Beach Spawners	Habitat Condition #3	Lake Ozette	Develop a comprehensive understanding of the conditions, factors, and processes controlling egg-to-fry survival on sockeye spawning beaches. Increase the quantity and quality of beach spawning habitat.
<b>RME#19</b>	Tributary Spawners	Riparian	All tributaries	Conduct additional series spruce-alder mixture trials to compare density/proportion/overstory thinning treatments on primary growth and resilience against pests.

PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

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<b>RME#20</b>	Tributary Spawners	Hydrology	All tributaries	<p>Long-term streamflow data would allow for a better understanding of the impacts streamflow has on adult sockeye spawning locations in tributaries. Tradeoffs exist between spawning low in a cross-section and avoiding dewatering, compared to spawning higher in the cross-section and avoiding bedload transport and scour. High streamflow variability during the sockeye spawning and incubation period can result in reduced probabilities of successful egg-to-fry survival. Quantification of natural and human-included streamflow impacts on egg-to-fry survival in Ozette tributaries remains a major data gap.</p>
<b>RME#21</b>	Tributary Spawners	Sediment	All tributaries	<p>Collection of continuous turbidity and SSC measurements in all Ozette sockeye tributaries needs to be expanded upon over the long-term, with the goals of understanding the magnitude and duration impacts of high sediment loads on adult sockeye spawning in tributaries and detecting long-term (5-10+ year) trends in turbidity and suspended sediment concentration.</p>
<b>RME#22</b>	All	All	All Tributaries	<p>Develop and implement several projects that examine the effectiveness of HCP prescriptions and “rules” at restoring watershed processes and habitat conditions.</p>
<b>RME#23</b>	Tributary Spawners	Habitat Quantity	All tributaries	<p>In many Ozette tributaries, the quantity of suitable spawning habitat area has been reduced as a result of the effects of LWD</p>

PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

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				removal, reduced LWD recruitment, increased fine sediment inputs and abundance, channelization and bank armoring, gravel mining, and colonization of bar deposits by non-native vegetation. In some reaches of Big River and Umbrella Creek, spawning gravel beds have been completely converted to sand bed or cobble bed, respectively. No attempts have been made to quantify loss of available spawning habitat over time, which remains a data gap.
<b>RME#24</b>	NA	NA	All tributaries	Clallam County: monitor and report on regulated activities in Ozette watershed (e.g., track land use changes).
<b>RME#25</b>	NA	NA	All	Develop Internet-based database containing all datasets specific to Ozette sockeye and sockeye recovery efforts (e.g., streamflow, sockeye counts, water temperature).

PROPOSED RECOVERY PLAN FOR LAKE OZETTE SOCKEYE SALMON

RM&E ID	Affected Population Segment	Process or Condition to Investigate	Geographic Location	Description
<b>RME#26</b>	All Population Segments	Biological / Water Quality	Lake Ozette	Continue and expand upon investigative studies of mercury and other environmental toxins entering the Lake Ozette food web. Determine and monitor the levels of mercury and other environment toxins within Lake Ozette sockeye at all freshwater life history stages.